7· McKern A-4,5 (1920-1921) 1929 OU9 Tonga OU9

STONE CONSTRUCTION

KIND AND SOURCE OF MATERIALS

In building mounds, platforms, monuments, fortifications, walls, enclosures and miscellaneous structures, the ancient Tongans made large use of stone. The most common structures are masses of loose earth and gravel supported by retaining walls of both natural and dressed stones. Two kinds of stone were available, basalt and limestone. The basalt is on volcanic islands not conveniently near the larger, more densely populated coral islands; moreover, it is difficult to work with primitive tools. Though many native stories tell of *makahuna* (volcanic rock) brought from distant islands and extensively used, I saw only a few, small, undressed pieces of basalt forming part of the old structures. Limestone, however, is abundant, easily accessible, and presents varieties suitable for various purposes. The limestone forming the reef itself is massive, rough, compact, and without cleavage planes helpful to the mason. Though difficult to quarry, it possesses great strength and is the source of the thick long blocks needed for the largest structures. The kind of limestone commonly used (locally called "sandstone") consists of the lime sand of the beaches blown onto the shore and inland where it becomes consolidated into a stratified rock. Because it is composed of a series of superposed layers, it is easily quarried and broken into rectangular slabs suitable for retaining walls.

QUARRYING METHODS

Stone quarries are to be found at many places where suitable rock outcrops. Quarries of considerable extent were observed on the islands of Lifuka, Mango, Uiha, and Ualeva in the Haapai group, and on Motutapu and Pangaimotu in Tongatabu. The largest quarry seen is on the northeast shore of Motutapu Island, where a bed rock 50 yards in length has been exposed and intensively worked. The stone slabs obtained from the quarry were 0.7 foot to 1.5 feet in thickness. Among the largest intaglios marking the removal of slabs is one which measures 10.5 by 6.3 feet by 0.6 foot, another, 10 by 6 feet by 0.6 foot, and a third, 9 by 8 feet by 1 foot. On some slabs, quarrying had been begun but not completed. The information obtained from these remnants of unfinished work regarding the successive stages of operations coincides exactly with that gathered from living informants.

The procedure was as follows. An area of desired size and shape was marked out on the rock surface. Large axes (*toki lahi*), fashioned of basalt and finished with faces tapering abruptly away from a blunt edge, were then employed to cut a groove around this outlined area. This groove was carried

7: McKern A-4,5 (1920-1921) 1929 OU9 Tonga OU9

Tongan pottery seems to resemble that of Fiji in many essential traits, as is to be expected, but to differ somewhat from it in many details. The similarity between the cooking wares is much more pronounced than that between the finer, decorated ware.

Good sources of clay in Tonga were not observed, but there were volcanic as well as coral islands in the group to serve as possible sources, and clay is probably not uncommon. There certainly is no lack of stubborn, sticky mud, as the roads will testify.

CONCLUSION

The culture traits and products disclosed by archaeological investigations in Tonga are representative of the entire group rather than of peculiarly different districts; a single culture was disclosed. Certain rare, unique features may have been either local peculiarities within the culture, isolated innovations resulting from foreign diffusion, or monuments of an intruding culture. Their rare occurrence renders them generally unimportant. A list of these unique features might include the Fijian type of house platform observed on the island of Mango, the square house platform on the island of Utungaki, the stone fortification on the island of Late, the petroglyphs on the islands of Telekivavau and Tonumea, and even the great trilithon on Tongatabu.

On the other hand, the Tongan tendency towards the quick adoption of new ideas, whether of local or foreign conception, a characteristic very apparent in the historic Tongan, could only have resulted in a mottled culture with many peculiar expressions, which might have included any or all such highly individualistic features.

Not only are sub-divisions of negligible importance in this province, but no reasonable indication of a human culture or foreign race of people preceding the culture and race of its historic occupation was encountered. This statement is made with a full realization of the paucity of known data reflecting any great antiquity, but with the feeling that this paucity is principally due to the non-existence of such data.

A great part of the investigation was limited to the Tongatabu group of islands. This was not due to any arbitrary selection on my part, but rather to the illuminating fact that sites apparently worthy of investigation, considering the limited time available for work, are relatively rare elsewhere. This is true of structures of stone and earth, accumulations of kitchen refuse, and all other interesting features, definitely indicating a much more intesively inhabited state in the south of the archipelago than in the north. Native traditions to the effect that Tongatabu was settled before Haapai and Vavau, and that these groups remained but sparsely settled until con-

14: Thomson G-3 (1886-1891) 1894
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000 gotten, the primitive method of raising weights is likely to prevail in that district. I asked the old men what they did with heavier weights still, and they immediately answered, "We make the platform of earth, and dig it away to make the log tip up." No doubt, when the log or stone is on end, they dig away the platform, throwing the earth into its old position, so that no trace remains. Having seen the whole process, I shall continue to believe that Stonehenge was built like this, until some one offers a better explanation.

349 There is a legend that the Haamonga stones were [773] brought by the god Maui in a gigantic canoe from Uea [823] (Wallace Island), and that you may see there great holes in the rock whence they were quarried. A European even assured me that the stone is of a kind not found [135] in Tonga at all. This part of the story at least is not true, for the stone is mere coral, hardened by exposure, of exactly the same quality as the reef close by.

136 In discussing the peculiarities of man I have altogether neglected the lower animals in Tonga. The only indigenous mammals were a small field-rat, a fruit-eating bat [226] or flying fox, and a small cave-bat. The rat, having no [526] enemies but man, swarmed throughout the islands: so numerous were they that it was a chieflike sport to shoot them in the paths with a bow and arrow. They have almost vanished now before the cats, dogs, and their voracious Norway cousin, and rat-shooting is now as extinct as bear-baiting in England.

[231] The first foreign arrival was of course the pig. It is a [177] popular fallacy that Captain Cook, among his other benefi-

21: Simkin U-5 (no date) 1945 OU9 Tonga OU9

without spelling, probably owing to deficiencies of potash. There are no minerals in Tonga, and no forest resources of value.

The islands in the volcanic chain are of little account. Only Niua Fo'ou, Niuatobutabu, and Tafahi are large or safe enough to be peopled, and they contain less than a tenth of the population. Two of them, however, have attracted some fame, Niua Fo'ou because of its Tin-Can Mail, and Falcon Island because of its periodic disappearances. This jack-in-a-box island is associated with an active volcano, whose eruptions occasionally leave a raised surface of ash and scoria which sea and rain later wash away.

The eastern chain is divided into three groups, Tonga Tapu in the south, Ha'apai in the centre, and Vavau in the north. Tonga Tapu contains about half the Kingdom's habitable area, and half its people (16,234). Ha'apai has nearly the same population as Vavau, but less than half its habitable area.[2] Each group has a serviceable port, Nukualofa in Tonga Tapu being the most important and also the capital.

Climatically[3] the Kingdom is well favoured, since it lies in the zone of the southeast trades, and has no orographical obstructions to cause rain and high humidities. The tropical Niuas have much the same rainfall and temperature as Apia and Suva, but the other groups have

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[2] The following statistics illustrate the size, distribution, and density of the population (1939 Census)

Group	Population	Tongans	Habitable Area	Persons per sq. mile	Percentage of Tongans
			sq. miles		
Tonga Tapu	16,234	15,324	134.8	120	47
Ha'apai .	7,483	7,383	24.3	308	22
Vavau . .	8,199	7,957	56.1	143	24
Niuas . .	2,214	2,198	20.6	108	7
TOTAL . .	34,130	32,862	235.8	145	100

[3] The following climatological statistics (supplied by the Director of Meteorological Services, Air Department, New Zealand) illustrate in outline Tonga's principal climatic characteristics:

	Nukualofa	Vavau
Annual mean sea-level pressure (mbs)	1014	1013
Annual mean air temperature (°F)	74	78
Annual mean daily maximum temperature (°F)	80	82
Annual mean daily minimum temperature (°F)	68	72
Average annual rainfall (ins.)	63.45	77.57
Percentage of winds between south and east	72	68
Average wind force in morning (m.p.h.)	8	6
Average wind force in afternoon (m.p.h.)	10	7
Annual average relative humidity (a.m.)	79%	77%
Annual average relative humidity (p.m.)	73%	—
Annual mean of sea temperature (°F)	77	79

22: West M-3 (1846-1855) 1865 OU9 Tonga OU9

The deliberative assemblies of the chiefs were very stately affairs. Each sat in a circle, arranged according to the rank and precedence of those who composed it, where speeches were made by the authorized orators, and by some of the leading chiefs; after which, the ceremony of kava-drinking would be proceeded with. These meetings would often extend over several hours; and every part of the proceedings was governed and conducted according to well-known and rigid laws of etiquette. From these assemblies the knowledge of new enactments, or the arrangements adopted for any projects entertained by the chiefs, was circulated among the people at large by the *Matabules*.

We now pass on to a brief consideration of the knowledge of the Tonguese, as developed in their arts, manufactures, and customs. In estimating these, however, the fact must not be overlooked, that as their land yielded no metals, and but few minerals, the resources of the islands, for the production of manufactures, were extremely limited. Indeed, it may be asserted that they carried civilization, in this point, to the full extent of their feeble means. The credit must be awarded them, of displaying no small amount of ingenuity and skill in what they produced.

The warlike weapons of the Tonguese were few and simple. They consisted of spears, javelins, and clubs, made from various kinds of hard and heavy wood, capable of taking a high polish. In their hands, these were most effective weapons. They were also very clever in the use of bows and arrows, and slings. Defensive armour was seldom employed; and great ingenuity was displayed in painting and decorating the person, in preparation for an expected contest.

96: Lister N-5 (1889-1890) 1891
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Some miles to the westward of Mango is the small island of Nomuka-iki (=little Nomuka), to the south of Nomuka, and separated from it by a narrow channel. This island is about 60 feet high, and one mile in its longest diameter; it also is formed in part of a hill of volcanic tuff, the remainder consisting of a flat of calcareous sand. The layers are horizontal and are made up of finer and coarser beds of brown and grey ashes alternating with one another. Here there are no fragments of coral mixed with the ashes. A fossil univalve of the genus *Pyrula* occurred in these beds, and some of the finer ones contained vertical burrows (of an annelid?) which were filled in with the coarser material of the overlying layer.

As at Mango, there are no raised coral-rocks overlying the volcanic beds, although broad fringing reefs surround the shores.

The beds have evidently been laid out by water, but under quieter conditions than those of the neighbouring island, and the mound has since been elevated to its present height.

A little to the south of Mango are the two islands Tonumeia and Kelefasia. Capt. Oldham visited Tonumeia when engaged in the survey of the group in 1890. He found it to consist of volcanic tuffs forming a cliff 80 feet high, and dipping at an angle of 3° to the south *. Mr. Harker finds that a specimen of these beds consists of "fine volcanic ash compacted by a calcareous and ferruginous cement into a yellow-brown rock."

Capt. Oldham also obtained some black nodules two inches in diameter, with portions of a calcareous matrix still adherent, and which had presumably weathered out of the layers of tuff. Mr. Harker describes these as consisting of oxide of manganese having "the general characters of psilomelane, but soft and of a low specific gravity, and therefore perhaps altered."

The presence of these nodules, supposing them to have occurred naturally in the beds of which Tonumeia is composed, is very remarkable. They are generally supposed to be formed only in deep water; but the situation of the island on the same shallow plateau as Mango and Nomuka-iki, and the general correspondence of its formation with theirs, point strongly to the conclusion that these islands were all formed under similar conditions. The presence of coral and other organic remains amongst the volcanic constituents of these islands shows that they were formed in shallow water.

Judging by its appearance as seen from the sea, I have little doubt that Kelefasia belongs to the same class of islands.

The island Tonua, to the north-east of Mango, was also examined by Capt. Oldham. It is composed of yellowish-white rocks which form a cliff twenty feet high, and consist of volcanic ashes with little calcareous matrix, though shells of pteropods and the cast of a gasteropod (*Murex*?) were found among the volcanic fragments †.

In the central part of the Hapai group there are two islands,

* The substance of Capt. Oldham's report on this island and Tonua is given in Mr. Harker's paper in the Geol. Mag. for June, 1891.

† Harker, *op. cit.*

96: Lister N-5 (1889-1890) 1891
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[Eua Island]

133 (135) Among the volcanic fragments Mr. Harker has detected red garnet and tourmaline, whose presence indicates the existence of metamorphic rocks somewhere in the vicinity.

A similar partly calcareous rock occurs at the northern end of terrace *b*, where the volcanic basis is exposed *.

(134) The uppermost part of the volcanic formation consists of red, yellow, and brown beds of ashes, which are very much decomposed by weathering. Some are nearly horizontal, others a good deal contorted, but they are never, so far as I observed, regularly inclined at an angle, as though they had formed part of a volcanic cone.

As mentioned above, dykes of intrusive rock project on the eastern shore. They are composed of augite- and hypersthene-andesites. (412) Large rounded boulders of this rock, mixed with boulders of coral, form the shore, and the natives obtain here the hard (276) rounded stones which are used for pounding the root of the kava plant, in the preparation of the beverage of that name. The dykes penetrate the beds of tuff and form well-marked projections at the surface; they do not, however, penetrate the overlying limestone.

Besides the intrusive rocks there is a crystalline, plutonic rock in this part of the island, of which I obtained a specimen from a boulder on the shore. Mr. Harker describes it as "uralitized gabbro." Although I did not find this rock *in situ*, I have no doubt that it exists as a natural constituent of the island. It is highly improbable that a boulder should be brought here by artificial means, for there is no possible landing-place for vessels along the whole of this eastern coast, and the only access to it from the anchorage on the western side is by steep hill-paths. A reef about 100 yards wide stretches out from the shore, and on the edge of this reef a vessel would strike, supposing one to be wrecked. I think therefore it may be concluded that the rock occurs naturally on the island.

The volcanic basis of Eua appears to have been produced by an extensive submarine eruption which formed a mound of considerable extent, and into which lava was injected.

The eruption seems to have occurred at some depth, for the organisms found mingled with the volcanic materials are, according to Dr. Murray, pelagic and not shallow-water forms. Subsequent to its formation and the cessation of the volcanic forces, but prior to the deposition of the overlying limestones, the mound was elevated to at least its present height and considerably denuded. The evidence for this denudation is afforded by the elongated shape, and the steepness of the eastern slope of the volcanic basis which underlies the limestone; these imply the removal of a considerable part of the original mound, which is built up in the main of horizontal layers. After its denudation the island subsided again, before the deposition of the limestone formation.

The limestones invest nearly the whole of the lower part of Eua up to a level of about 500 feet, and above this level they occur, though less continuously, as high as the summit.

* Slide No. 1273.

101: Clark K-4,5 (1974) 1978 OU9 Tonga OU9

manufacturing techniques, crop and soil science, as well as animal husbandry seem appropriate areas of emphasis given Tonga's economic profile.

It is recognized any change in policy or the implementation of the above recommendations require capital outlays involving land, population and urban conditions making it imperative that the government reorder its current development priorities. This investigation concludes that a pessimistic aura regarding the future of Tonga remains. Given the social structuring and system of land tenure and agriculture, coupled with a numerically increasing and urbanizing population, Tongan government officials must face several hard realities. The nation lacks to date any economically exploitable resources save its agricultural acreage or possibly the fishing resources in surrounding ocean waters outside the reef areas. Talk of economic schemes and wealth from underseas deposits of petroleum or minerals has largely proven to be rhetoric. Tonga must quickly come to grips with the economic and population crises which are already the cause of discontent in several significant sectors of the population. Yesterday's factors of risk concerning overpopulation, malnourishment and economic instability are rapidly becoming realities of today.